OT-2026-000000060

Vibration-Resistant Machine Leveling Element with Positive Locking and Sensing

Published	September 15, 2026 at 11:58:06 UTC
Permanent URL	https://opentechnical.org/p/OT-2026-000000060
Classification	Industrial Components, Safety & Infrastructure > Structural Components > Levelling Elements
Document SHA-256	0c54f0e8a6e7d58aa23d978e9f904fafb06ecc8a91fdb3ec7488ee2506246983
Extent	2,298 words, 17 numbered paragraphs, 2 figures

Abstract

A machine levelling element is disclosed, designed to maintain precise machine base alignment over extended operational periods despite dynamic loading and vibration. It integrates an adjustable support, a positive mechanical locking mechanism, and an embedded sensing capability. The locking feature prevents gradual loosening common in conventional adjustable feet, addressing the problem of machines losing level and causing process drift. The sensing capability facilitates timely detection of any level deviation without requiring external survey equipment, enabling scheduled re-levelling procedures to restore original machine alignment.

1. Technical Field

[0001] The present disclosure relates to structural components for industrial machinery, specifically concerning adjustable levelling elements designed to support and precisely align machine bases. More particularly, it pertains to levelling elements that incorporate features for maintaining alignment stability under dynamic loads and for detecting deviations from a set level.

2. Technical Context

[0002] Industrial machinery often requires precise horizontal alignment or specific angular orientation to operate within design tolerances. This alignment is typically achieved by supporting the machine base on a foundation using adjustable levelling elements. A common problem in such installations is the gradual loss of the initial level setting over extended operational periods. This degradation can be caused by various factors, including persistent mechanical vibration transmitted through the machine or foundation, thermal expansion and contraction cycles, creep in the foundation material, or settling of the machine's supporting structure. When a machine loses its precisely set level, the symptom often manifests as a drift in process parameters, reduced product quality, increased wear on machine components, or compromised operational efficiency. Conventional levelling elements, which frequently rely on friction or simple lock nuts, can gradually loosen under dynamic conditions, allowing the machine to "walk" out of level. Re-levelling typically requires a dedicated survey using precision instruments, which can be time-consuming and disruptive to production. There is a need for levelling solutions that offer enhanced long-term stability against vibration-induced drift and provide a means for detecting level deviations without requiring specialized external equipment.

3. System Overview

[0003] The disclosed system comprises one or more levelling elements (04) that support a machine base (02), as generally depicted in FIG. 1. Each levelling element (04) integrates an adjustable vertical support mechanism, a positive mechanical locking feature to resist loosening from vibration, and an embedded level sensor (24). The levelling elements (04) are arranged beneath the machine base (02) at designated support points. The level sensor (24) within each levelling element (04) provides an electrical signal indicative of its tilt or inclination relative to a reference plane. These sensor signals are routed to a sensor signal aggregator (06), which collects and processes the data from multiple levelling elements. The aggregated data can then be transmitted to a display unit (08) for operator monitoring or to a control system for automated analysis. This arrangement allows for the continuous or periodic monitoring of the machine's level status, enabling early detection of any alignment drift. The integrated locking mechanism ensures that once a desired level is set, it is maintained with high stability over time, reducing the frequency of re-levelling events.

4. Components

[0004] A detailed cross-section of a levelling element (04) is shown in FIG. 2.

[0005]

- **Base Plate (10):** A robust, flat plate that rests directly on the foundation or floor. It provides a stable footing for the entire levelling element assembly and typically features bolt holes for anchoring to the foundation if required. The base plate (10) is designed to distribute the machine load over a sufficient area of the foundation.
- **Adjustment Screw (12):** A threaded rod, often with a fine pitch, that passes vertically through a central bore in the base plate (10). One end engages with a threaded bore in the machine foot pad (16) or a mating component attached to the machine base (02). Rotation of the adjustment screw (12) raises or lowers the machine base (02) relative to the foundation.
- **Spherical Washer (14):** A two-part washer system, consisting of a concave and a convex surface, placed between the machine foot pad (16) and the lock nut (18) or directly under the machine foot (16). This component accommodates slight angular misalignment between the machine base (02) and the adjustment screw (12), ensuring even load distribution and preventing bending moments on the adjustment screw (12).
- **Machine Foot Pad (16):** A component attached to the machine base (02) that rests upon the levelling element (04). It typically has a flat underside that interfaces with the spherical washer (14) or directly with the top of the adjustment screw (12).
- **Lock Nut (18):** A threaded nut that engages with the adjustment screw (12) and is tightened against the base plate (10) or a collar on the adjustment screw (12). In conventional systems, this nut provides the primary locking action, but here it acts as a preload element for the locking wedge (20).
- **Locking Wedge (20):** A tapered component designed to exert a radial or axial force when driven into a corresponding tapered recess or against a complementary surface. In this disclosure, it functions as a positive mechanical lock. It may be a single wedge or a set of opposing wedges.
- **Wedge Retainer (22):** A housing or collar that retains the locking wedge (20) and provides a surface against which the wedge can be driven to create the locking force. It may be integrated with the base plate (10) or be a separate component.

- **Level Sensor (24):** An inclinometer or tilt sensor embedded within the base plate (10) or the wedge retainer (22) of the levelling element (04). This sensor provides an electrical output signal, such as an analog voltage or a digital reading, proportional to the angular deviation from a horizontal reference plane.

5. Operation

[0006] The operation of the levelling element (04) involves initial setup, steady-state running with level monitoring, and a re-levelling procedure.

[0007] **Initial Setup and Levelling:**

[0008]

- The machine base (02) is positioned approximately on its foundation. Levelling elements (04) are placed under designated support points, with their base plates (10) resting on the foundation.
- The adjustment screws (12) are initially backed off, and the locking wedges (20) are disengaged or in a released state.
- Each adjustment screw (12) is rotated to raise the corresponding section of the machine base (02). This adjustment is performed incrementally across all levelling elements (04) until the machine base (02) is brought to the desired level or angular orientation, as indicated by external precision levelling instruments or by the readings from the embedded level sensors (24) after initial calibration.
- Once the desired level is achieved, the lock nut (18) for each levelling element (04) is tightened against the base plate (10) or a collar, preloading the system.
- The locking wedge (20) is then engaged. This typically involves driving the wedge (20) using a set screw or a cam mechanism into its tapered seating within the wedge retainer (22). As the wedge (20) is driven, it generates a radial or axial force that positively locks the adjustment screw (12) in its position, preventing rotation or axial movement. This locking force is designed to be significantly higher than frictional forces alone, providing resistance against vibration.

[0009] **Steady-State Running and Level Monitoring:** During normal machine operation, the levelling elements (04) continuously support the machine base (02). The load path from the machine base (02) travels through the machine foot pad (16), spherical washer (14), adjustment screw (12), lock nut (18), and then through the base plate (10) to the foundation. The locking wedge (20) ensures that this path remains rigid and that the adjustment screw (12) does not rotate or settle. The embedded level sensor (24) in each levelling element (04) continuously or periodically reports its inclination. These signals are collected by the sensor signal aggregator (06) and displayed on the display unit (08). A baseline set of readings is established during initial levelling. During operation, these readings are compared against the baseline. If any sensor reading deviates beyond a predefined threshold (e.g., 0.005 degrees), an alert can be generated, indicating that the machine's level may have drifted. This allows for detection of level loss without requiring manual surveys.

[0010] **Fault or Interruption (Level Deviation Detection and Re-Levelling):** If the level monitoring system indicates a significant deviation from the set level:

[0011]

- The machine operation may continue if the deviation is within a tolerance that does not critically affect the process, but the deviation is noted for scheduled maintenance.

- For larger deviations, or high-precision applications, the machine may be idled or shut down.
- The re-levelling procedure begins by disengaging the locking wedge (20). This typically involves backing off the set screw or releasing the cam that drives the wedge, allowing the wedge (20) to retract.
- The lock nut (18) is then loosened to free the adjustment screw (12) for rotation.
- The adjustment screw (12) is rotated to bring the machine back to the desired level, using the real-time feedback from the level sensors (24) and potentially external instruments for verification.
- Once the correct level is re-established, the lock nut (18) is tightened, and the locking wedge (20) is re-engaged to secure the new setting, as described in the initial setup.

6. Example Embodiments

[0012] **Embodiment 1** This embodiment features a single tapered locking wedge (20) that engages axially. The adjustment screw (12) has a conical section machined into its lower shaft, below the lock nut (18). The locking wedge (20) is a split conical collet that sits within a tapered bore in the wedge retainer (22). When an actuation screw, perpendicular to the adjustment screw (12), is tightened, it forces the split collet wedge (20) to contract onto the conical section of the adjustment screw (12), creating a high-friction, positive lock. The level sensor (24) is a MEMS inclinometer integrated into the base plate (10), powered by a low-voltage DC supply and outputting a serial digital signal.

[0013] **Embodiment 2** In this embodiment, the locking mechanism employs a pair of opposing wedges. The adjustment screw (12) passes through a rectangular slot in the base plate (10) that is wider than the screw's diameter. Two flat wedges (20) with complementary tapers are inserted from opposite sides into this slot, between the adjustment screw (12) and the walls of the slot. A differential screw mechanism drives these two wedges (20) simultaneously towards each other, clamping the adjustment screw (12) firmly in place. This arrangement provides a strong clamping force resistant to rotation and axial slip. The level sensor (24) is a fluid-filled bubble sensor with optical detection, providing an analog voltage output directly proportional to tilt.

[0014] **Embodiment 3** This embodiment utilizes a cam-actuated locking mechanism. The adjustment screw (12) has a grooved feature or a flat milled onto its side. A cam lever is integrated into the wedge retainer (22). When the cam lever is rotated, an eccentrically shaped cam surface presses a cam follower against the groove or flat of the adjustment screw (12). This action generates a substantial normal force, locking the adjustment screw (12) against lateral movement or rotation. The cam-based system allows for quick engagement and disengagement of the lock. The level sensor (24) is a capacitive tilt sensor, housed in a sealed enclosure within the wedge retainer (22), communicating wirelessly to the sensor signal aggregator (06).

7. Alternative Configurations

[0015] The spherical washer (14) may be replaced by a flexible elastomer pad or a self-aligning bearing element to accommodate angular misalignments and to dampen high-frequency vibrations. The adjustment screw (12) can be designed with an integral machine foot pad (16) feature, directly interfacing with the machine base (02). The level sensor (24) could be external to the levelling element (04) but mounted on a dedicated bracket attached to the base plate (10) for easier replacement or calibration. The sensor signal aggregator (06) could be distributed, with a small microcontroller embedded in each levelling element (04) performing local signal conditioning and transmitting data over a shared bus.

8. Parameter Variations

Parameter	Range	Effect of Increase	Effect of Decrease
Adjustment Screw Pitch	0.5 to 3.0 mm	Finer adjustment resolution, slower levelling speed	Coarser adjustment resolution, faster levelling speed
Locking Wedge Taper Angle	5 to 15 degrees	Higher locking force for given actuation force, greater self-locking	Lower locking force for given actuation force, easier to disengage
Base Plate Diameter/Side	50 to 200 mm	Increased load distribution area, greater stability	Reduced load distribution area, potentially higher foundation stress
Level Sensor Resolution	0.001 to 0.05 degrees	More precise deviation detection, higher sensitivity	Less precise deviation detection, lower sensitivity
Maximum Vertical Load Capacity	5 to 500 kN	Accommodates heavier machinery, larger components	Suitable for lighter machinery, smaller components
Material Hardness (Locking Parts)	40 to 60 HRC	Increased wear resistance, higher locking force capability	Reduced wear resistance, potential for deformation under high loads

9. Additional Implementations

[0017] The levelling element (04) can be adapted for use in cleanroom environments by specifying materials that do not shed particles and by sealing all moving parts with bellows or O-rings. For outdoor or corrosive environments, all components can be fabricated from corrosion-resistant alloys, such as stainless steel, and external surfaces can be coated with protective layers. The level sensor (24) can be integrated with a temperature sensor to compensate for thermal expansion effects on the reported level, providing a more accurate indication of physical tilt. The adjustment screw (12) could be motor-driven and connected to an automated control system, allowing for remote or automated re-levelling based on sensor feedback, without manual intervention. The base plate (10) may incorporate vibration isolation pads made from elastomeric materials to reduce the transmission of high-frequency vibrations from the foundation to the machine or vice-versa.

10. Figures

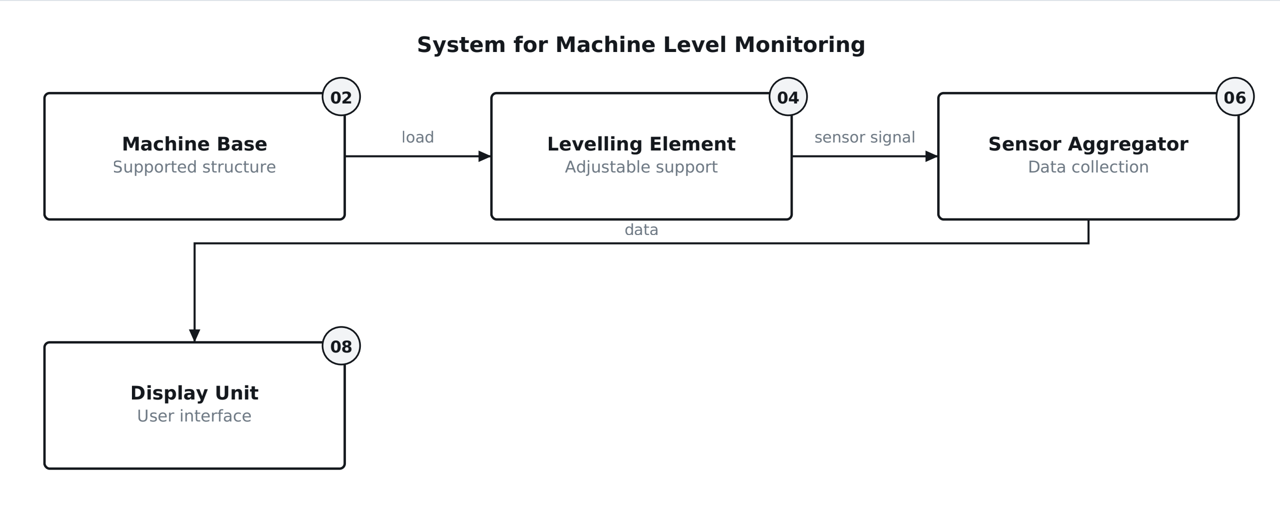

FIG. 1 FIG. 1 illustrates a system view of a machine base supported by multiple levelling elements with integrated level sensing. PNG

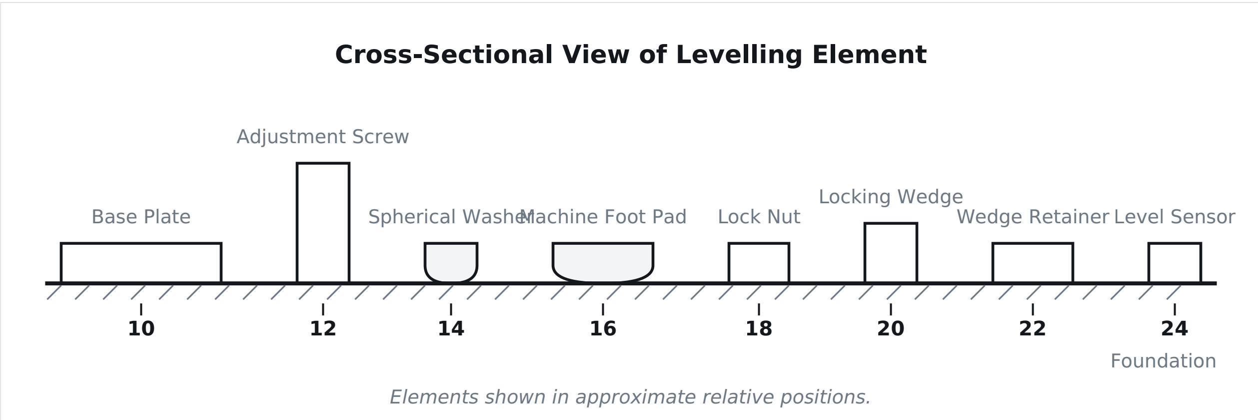

FIG. 2 FIG. 2 shows a cross-section of the levelling element highlighting the adjustment and locking features. PNG

OpenTechnical Publication OT-2026-000000060. Published September 15, 2026 at 11:58:06 UTC. https://opentechnical.org/p/OT-2026-000000060